**This key should allow you to understand why you choose the option you did (beyond just getting a question right or wrong). More instructions on how to use this key can be found here.**

**If you have a suggestion to make the keys better, please fill out the short survey here.**

*Note: This key is auto-generated and may contain issues and/or errors. The keys are reviewed after each exam to ensure grading is done accurately. If there are issues (like duplicate options), they are noted in the offline gradebook. The keys are a work-in-progress to give students as many resources to improve as possible.*

---

1. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{2}{3}, -7, \text{ and } \frac{7}{5}$$

The solution is $15x^3 + 74x^2 - 203x + 98$, which is option A.

A. $a \in [14, 16], b \in [74, 75], c \in [-204, -195], \text{ and } d \in [97, 102]$

* $15x^3 + 74x^2 - 203x + 98$, which is the correct option.

B. $a \in [14, 16], b \in [74, 75], c \in [-204, -195], \text{ and } d \in [-98, -96]$

$15x^3 + 74x^2 - 203x - 98$, which corresponds to multiplying everything correctly except the constant term.

C. $a \in [14, 16], b \in [83, 101], c \in [-98, -83], \text{ and } d \in [-98, -96]$

$15x^3 + 94x^2 - 91x - 98$, which corresponds to multiplying out $(3x + 2)(x + 7)(5x - 7)$.

D. $a \in [14, 16], b \in [-81, -66], c \in [-204, -195], \text{ and } d \in [-98, -96]$

$15x^3 - 74x^2 - 203x - 98$, which corresponds to multiplying out $(3x + 2)(x - 7)(5x + 7)$.

E. $a \in [14, 16], b \in [-116, -113], c \in [62, 71], \text{ and } d \in [97, 102]$

$15x^3 - 116x^2 + 63x + 98$, which corresponds to multiplying out $(3x + 2)(x - 7)(5x - 7)$.

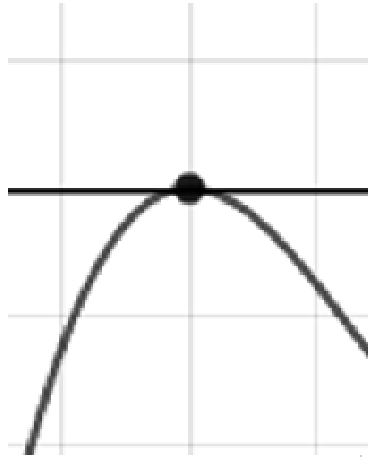
**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(3x - 2)(x + 7)(5x - 7)$

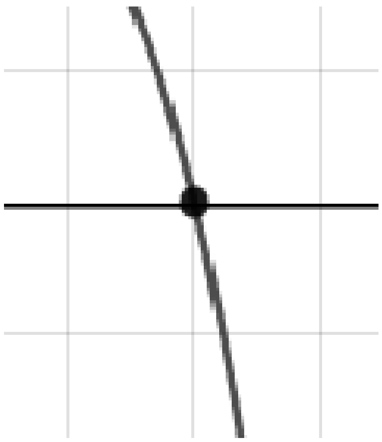
---

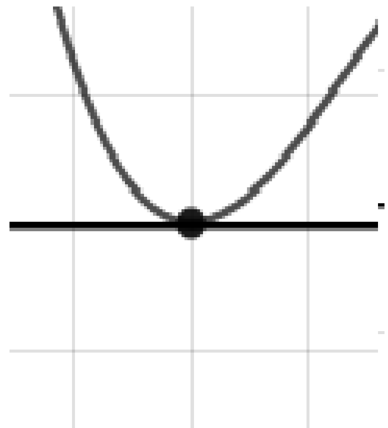
2. Describe the zero behavior of the zero $x = 8$ of the polynomial below.

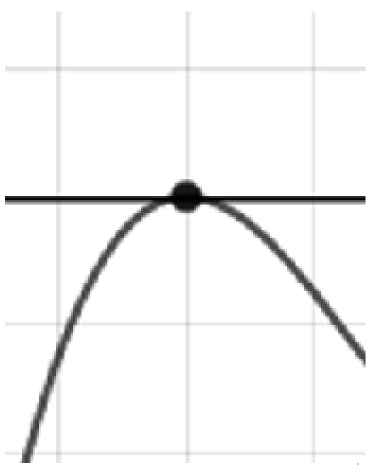
$$f(x) = -4(x + 8)^7(x - 8)^{10}(x - 4)^4(x + 4)^8$$

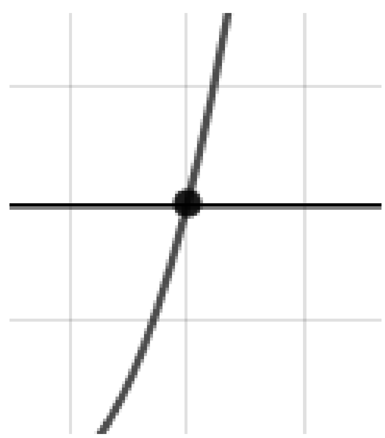
The solution is the graph below, which is option B.



A. 

C. 

B. 

D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

3. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-2 + 4i \text{ and } 4$$

The solution is $x^3 + 4x - 80$, which is option D.

A. $b \in [0.9, 2.6], c \in [-10, -4.4],$ and $d \in [15, 18]$

$x^3 + x^2 - 8x + 16$, which corresponds to multiplying out $(x - 4)(x - 4)$.

B. $b \in [-3.1, 0.1], c \in [2.6, 4.7],$ and $d \in [79, 82]$

$x^3 + 4x + 80$, which corresponds to multiplying out $(x - (-2 + 4i))(x - (-2 - 4i))(x + 4)$.

C. $b \in [0.9, 2.6], c \in [-6.7, 0.2],$ and $d \in [-12, -6]$

$x^3 + x^2 - 2x - 8$, which corresponds to multiplying out $(x + 2)(x - 4)$.

D. $b \in [-3.1, 0.1], c \in [2.6, 4.7],$ and $d \in [-82, -75]$

* $x^3 + 4x - 80$, which is the correct option.

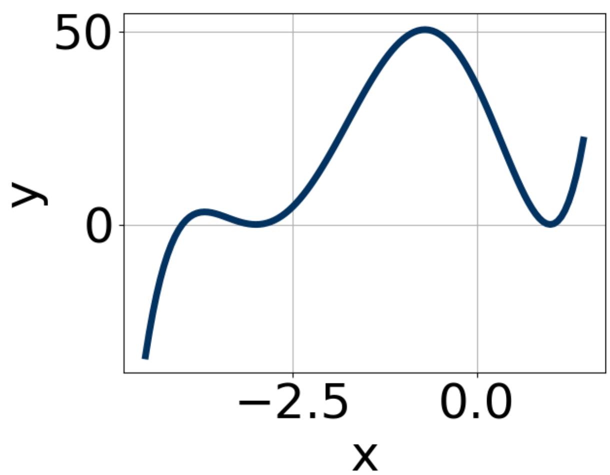
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

**General Comment:** Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (-2 + 4i))(x - (-2 - 4i))(x - (4))$.

---

4. Which of the following equations *could* be of the graph presented below?




The solution is $15(x - 1)^4(x + 3)^8(x + 4)^5$, which is option B.

A. $3(x - 1)^8(x + 3)^7(x + 4)^9$

The factor $(x + 3)$ should have an even power.

B. $15(x - 1)^4(x + 3)^8(x + 4)^5$

* This is the correct option.

C. $13(x - 1)^{10}(x + 3)^7(x + 4)^6$

The factor $(x + 3)$ should have an even power and the factor $(x + 4)$ should have an odd power.

D. $-5(x - 1)^6(x + 3)^4(x + 4)^4$

The factor $(x + 4)$ should have an odd power and the leading coefficient should be the opposite sign.

E. $-11(x-1)^{10}(x+3)^{10}(x+4)^{7}$

This corresponds to the leading coefficient being the opposite value than it should be.

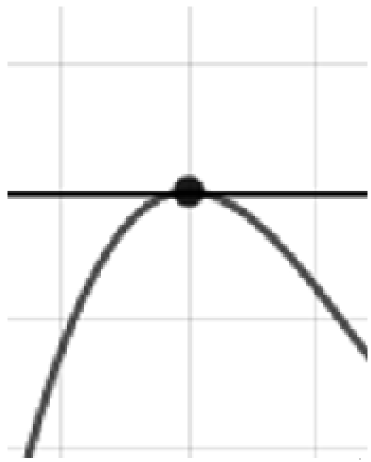
**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

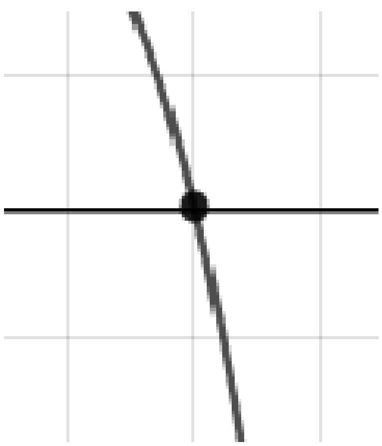
---

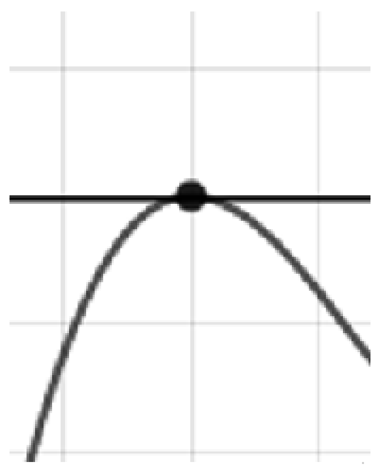
5. Describe the zero behavior of the zero $x = -5$ of the polynomial below.

$$f(x) = 6(x+8)^4(x-8)^2(x-5)^5(x+5)^2$$

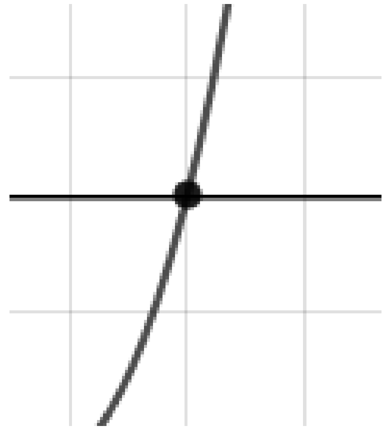
The solution is the graph below, which is option B.



A. 

B. 

C. 

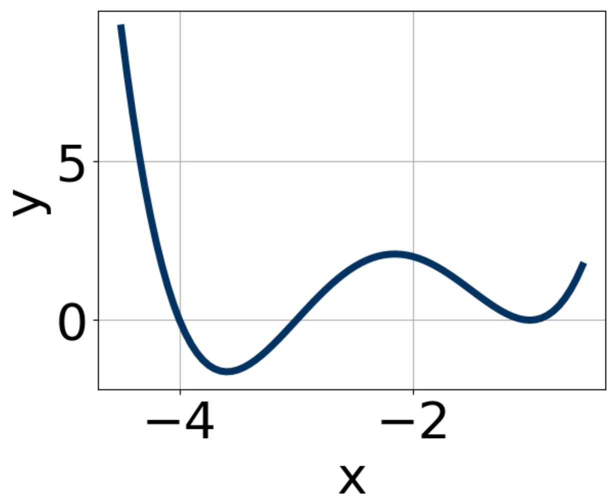
D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

6. Which of the following equations *could* be of the graph presented below?




The solution is $7(x+1)^8(x+3)^9(x+4)^{11}$, which is option C.

A. $-7(x+1)^6(x+3)^9(x+4)^7$

This corresponds to the leading coefficient being the opposite value than it should be.

B. $3(x+1)^5(x+3)^4(x+4)^5$

The factor $-1$ should have an even power and the factor $-3$ should have an odd power.

C. $7(x+1)^8(x+3)^9(x+4)^{11}$

* This is the correct option.

D. $-7(x+1)^4(x+3)^9(x+4)^{10}$

The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign.

E. $17(x+1)^6(x+3)^8(x+4)^5$

The factor $(x+3)$ should have an odd power.

**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

7. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$5 + 4i \text{ and } 2$$

The solution is $x^3 - 12x^2 + 61x - 82$, which is option A.

A. $b \in [-20, -7], c \in [60, 64.2],$ and $d \in [-82.1, -78.6]$

* $x^3 - 12x^2 + 61x - 82$, which is the correct option.

B. $b \in [-4, 6], c \in [-9.6, -6.6],$ and $d \in [8.9, 14]$

$x^3 + x^2 - 7x + 10$, which corresponds to multiplying out $(x-5)(x-2)$.

C. $b \in [12, 16], c \in [60, 64.2],$ and $d \in [79, 82.4]$

$x^3 + 12x^2 + 61x + 82$, which corresponds to multiplying out $(x-(5+4i))(x-(5-4i))(x+2)$.

D. $b \in [-4, 6], c \in [-6.7, -2.2],$ and $d \in [4.9, 9.8]$

$x^3 + x^2 - 6x + 8$, which corresponds to multiplying out $(x-4)(x-2)$.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

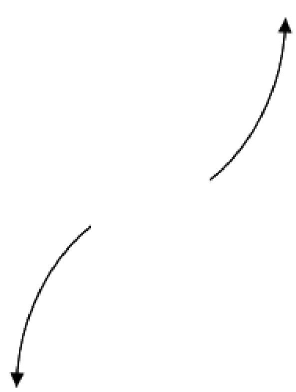
**General Comment:** Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x-(5+4i))(x-(5-4i))(x-(2))$.

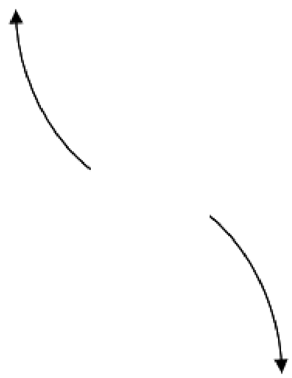
---

8. Describe the end behavior of the polynomial below.

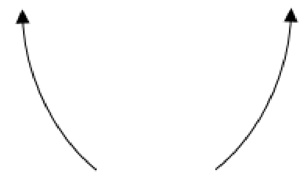
$$f(x) = 7(x+8)^4(x-8)^7(x+3)^3(x-3)^3$$

The solution is the graph below, which is option D.

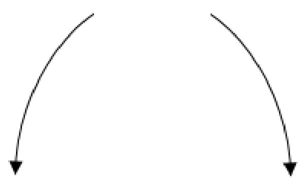




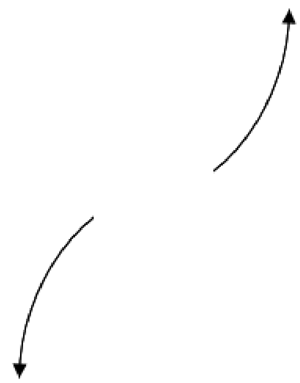
A.



C.



B.



D.

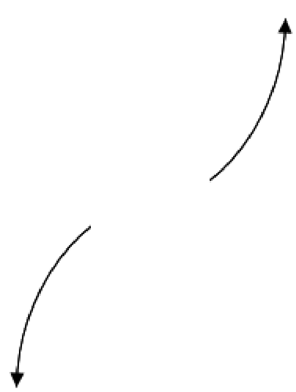
E. None of the above.

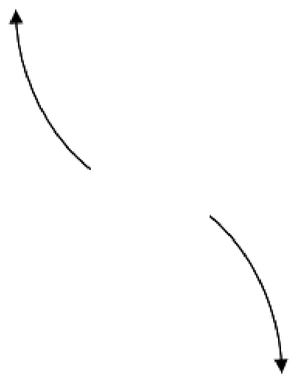
**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

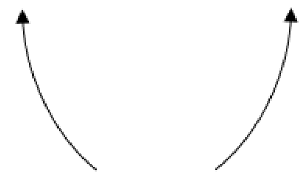
9. Describe the end behavior of the polynomial below.

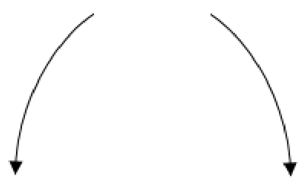
$$f(x) = 5(x+5)^3(x-5)^8(x-7)^3(x+7)^3$$

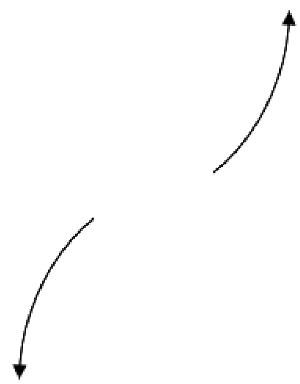
The solution is the graph below, which is option D.



A. 

C. 

B. 

D. 

E. None of the above.

**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

10. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-3}{2}, \frac{-4}{3}, \text{ and } \frac{-1}{4}$$

The solution is $24x^3 + 74x^2 + 65x + 12$, which is option B.

A. $a \in [21, 26], b \in [2, 9], c \in [-61, -45], \text{ and } d \in [-12, -9]$

$24x^3 + 2x^2 - 49x - 12$, which corresponds to multiplying out $(2x - 3)(3x + 4)(4x + 1)$.

B. $a \in [21, 26], b \in [69, 75], c \in [60, 68], \text{ and } d \in [9, 16]$

* $24x^3 + 74x^2 + 65x + 12$, which is the correct option.

C. $a \in [21, 26], b \in [-68, -61], c \in [27, 37], \text{ and } d \in [9, 16]$

$24x^3 - 62x^2 + 31x + 12$, which corresponds to multiplying out $(2x - 3)(3x - 4)(4x + 1)$.

D. $a \in [21, 26], b \in [69, 75], c \in [60, 68], \text{ and } d \in [-12, -9]$

$24x^3 + 74x^2 + 65x - 12$, which corresponds to multiplying everything correctly except the constant term.

E. $a \in [21, 26], b \in [-77, -65], c \in [60, 68], \text{ and } d \in [-12, -9]$

$24x^3 - 74x^2 + 65x - 12$, which corresponds to multiplying out $(2x - 3)(3x - 4)(4x - 1)$.

**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(2x+3)(3x+4)(4x+1)$

---

11. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3+bx^2+cx+d$.

$$\frac{-5}{3}, \frac{3}{5}, \text{ and } \frac{-4}{3}$$

The solution is $45x^3+108x^2+19x-60$, which is option A.

A. $a \in [42, 46], b \in [107, 114], c \in [12, 24]$, and $d \in [-67, -56]$

* $45x^3+108x^2+19x-60$, which is the correct option.

B. $a \in [42, 46], b \in [-42, -40], c \in [-92, -85]$, and $d \in [59, 61]$

$45x^3-42x^2-91x+60$, which corresponds to multiplying out $(3x-5)(5x-3)(3x+4)$.

C. $a \in [42, 46], b \in [9, 14], c \in [-111, -107]$, and $d \in [-67, -56]$

$45x^3+12x^2-109x-60$, which corresponds to multiplying out $(3x-5)(5x+3)(3x+4)$.

D. $a \in [42, 46], b \in [-114, -106], c \in [12, 24]$, and $d \in [59, 61]$

$45x^3-108x^2+19x+60$, which corresponds to multiplying out $(3x-5)(5x+3)(3x-4)$.

E. $a \in [42, 46], b \in [107, 114], c \in [12, 24]$, and $d \in [59, 61]$

$45x^3+108x^2+19x+60$, which corresponds to multiplying everything correctly except the constant term.

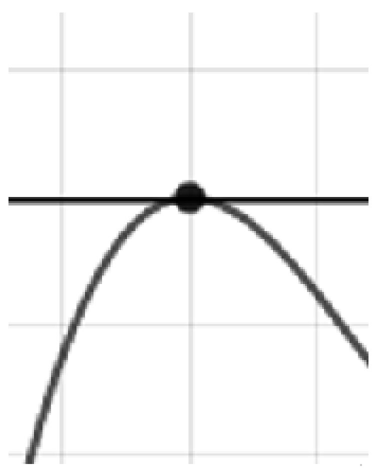
**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(3x+5)(5x-3)(3x+4)$

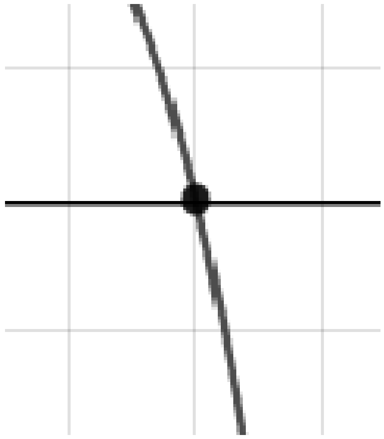
---

12. Describe the zero behavior of the zero $x=6$ of the polynomial below.

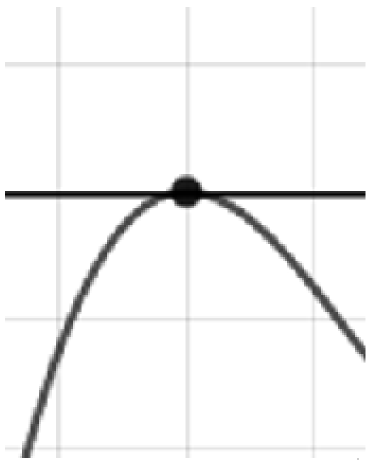
$$f(x) = -3(x+5)^{10}(x-5)^7(x-6)^{12}(x+6)^9$$

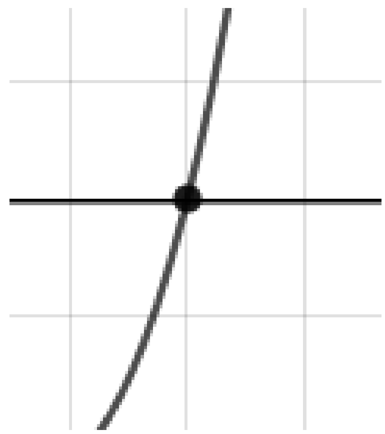
The solution is the graph below, which is option B.



A. 

C. 

B. 

D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

13. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$4 - 5i \text{ and } -2$$

The solution is $x^3 - 6x^2 + 25x + 82$, which is option D.

A. $b \in [1, 2], c \in [6, 8],$ and $d \in [9, 16]$

$x^3 + x^2 + 7x + 10$, which corresponds to multiplying out $(x + 5)(x + 2)$.

B. $b \in [6, 8], c \in [22, 31],$ and $d \in [-87, -77]$

$x^3 + 6x^2 + 25x - 82$, which corresponds to multiplying out $(x - (4 - 5i))(x - (4 + 5i))(x - 2)$.

C. $b \in [1, 2], c \in [-8, 5],$ and $d \in [-12, -6]$

$x^3 + x^2 - 2x - 8$, which corresponds to multiplying out $(x - 4)(x + 2)$.

D. $b \in [-6, -2], c \in [22, 31],$ and $d \in [75, 87]$

* $x^3 - 6x^2 + 25x + 82$, which is the correct option.

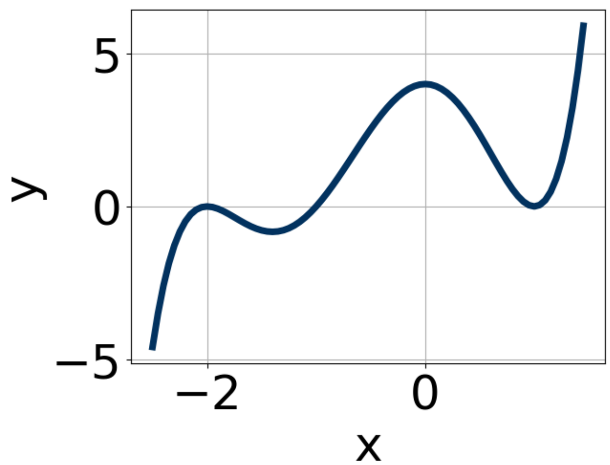
E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

**General Comment:** Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(4-5i))(x-(4+5i))(x-(-2))$.

---

14. Which of the following equations *could* be of the graph presented below?




The solution is $10(x+2)^6(x-1)^6(x+1)^5$, which is option B.

A. $-8(x+2)^{10}(x-1)^6(x+1)^8$

The factor $(x+1)$ should have an odd power and the leading coefficient should be the opposite sign.

B. $10(x+2)^6(x-1)^6(x+1)^5$

* This is the correct option.

C. $-15(x+2)^6(x-1)^4(x+1)^9$

This corresponds to the leading coefficient being the opposite value than it should be.

D. $5(x+2)^{10}(x-1)^{11}(x+1)^7$

The factor $(x-1)$ should have an even power.

E. $15(x+2)^{10}(x-1)^9(x+1)^6$

The factor $(x-1)$ should have an even power and the factor $(x+1)$ should have an odd power.

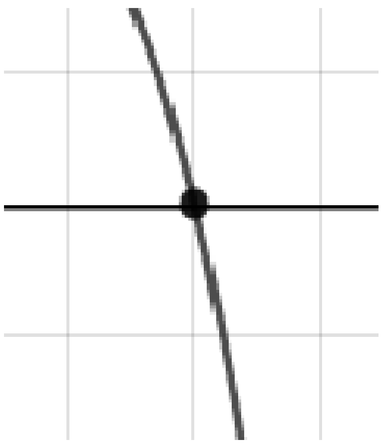
**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

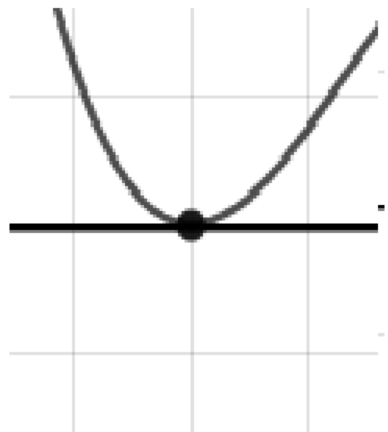
---

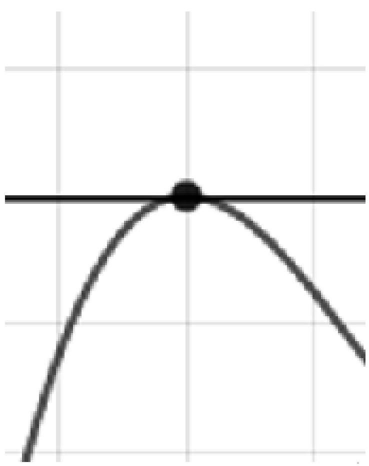
15. Describe the zero behavior of the zero $x=-6$ of the polynomial below.

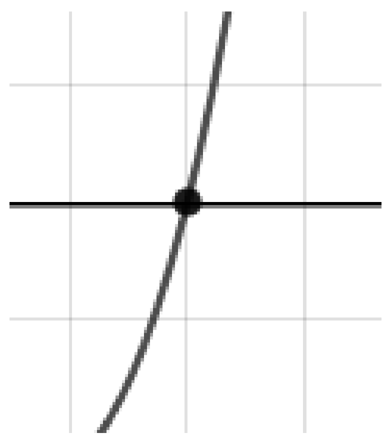
$$f(x) = -9(x-6)^9(x+6)^{14}(x+3)^4(x-3)^6$$

The solution is the graph below, which is option C.

A. 

C. 

B. 

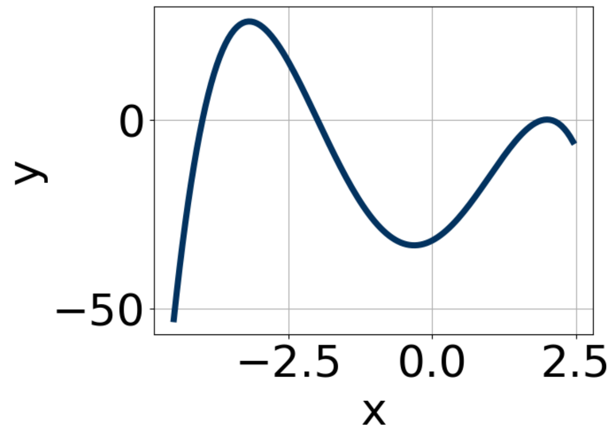
D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

16. Which of the following equations *could* be of the graph presented below?




The solution is $-11(x-2)^6(x+2)^{11}(x+4)^7$, which is option E.

A. $13(x-2)^8(x+2)^{11}(x+4)^{10}$

   The factor $(x+4)$ should have an odd power and the leading coefficient should be the opposite sign.

B. $4(x-2)^6(x+2)^5(x+4)^9$

   This corresponds to the leading coefficient being the opposite value than it should be.

C. $-12(x-2)^{10}(x+2)^8(x+4)^7$

   The factor $(x+2)$ should have an odd power.

D. $-14(x-2)^7(x+2)^4(x+4)^9$

   The factor 2 should have an even power and the factor $-2$ should have an odd power.

E. $-11(x-2)^6(x+2)^{11}(x+4)^7$

   * This is the correct option.

**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

17. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$-5 + 4i \text{ and } -3$$

The solution is $x^3 + 13x^2 + 71x + 123$, which is option D.

A. $b \in [-7, 6], c \in [1, 11]$, and $d \in [8, 23]$

   $x^3 + x^2 + 8x + 15$, which corresponds to multiplying out $(x+5)(x+3)$.

B. $b \in [-7, 6], c \in [-6, 2]$, and $d \in [-15, -11]$

   $x^3 + x^2 - x - 12$, which corresponds to multiplying out $(x-4)(x+3)$.

C. $b \in [-22, -12], c \in [69, 77]$, and $d \in [-125, -114]$

   $x^3 - 13x^2 + 71x - 123$, which corresponds to multiplying out $(x-(-5+4i))(x-(-5-4i))(x-3)$.

D. $b \in [10, 21], c \in [69, 77]$, and $d \in [115, 125]$

   * $x^3 + 13x^2 + 71x + 123$, which is the correct option.

E. None of the above.

This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

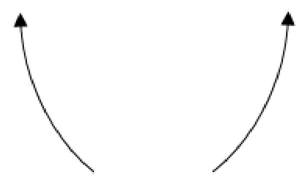
**General Comment:** Remember that the conjugate of $a+bi$ is $a-bi$. Since these zeros always come in pairs, we need to multiply out $(x-(-5+4i))(x-(-5-4i))(x-(-3))$.

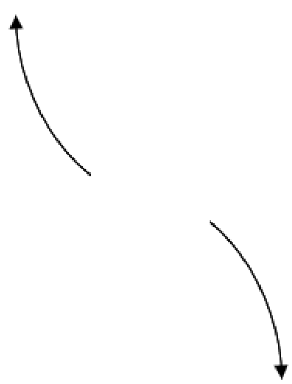
---

18. Describe the end behavior of the polynomial below.

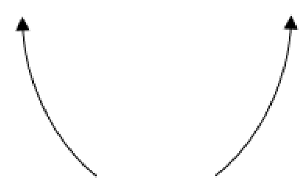
$$f(x) = 2(x+9)^3(x-9)^8(x+5)^3(x-5)^4$$

The solution is the graph below, which is option C.

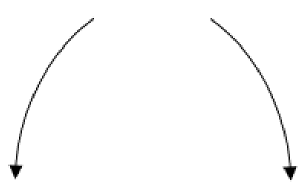




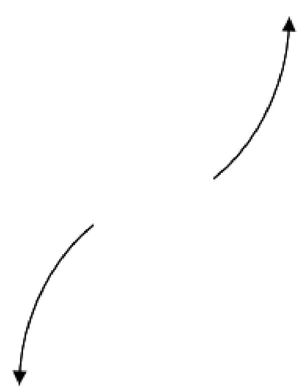
A.



C.



B.



D.

E. None of the above.

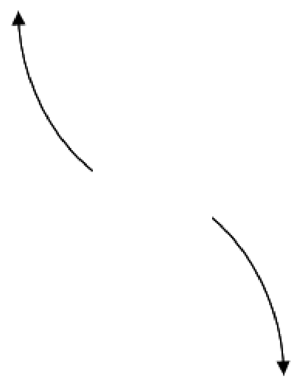
**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

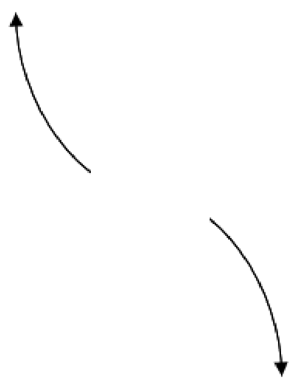
---

19. Describe the end behavior of the polynomial below.

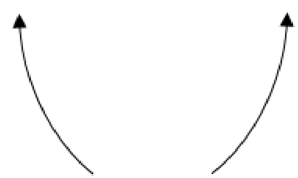
$$f(x) = -7(x-4)^5(x+4)^6(x-5)^4(x+5)^6$$

The solution is the graph below, which is option A.

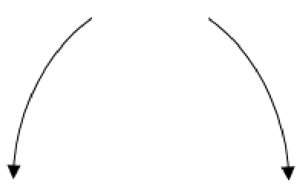




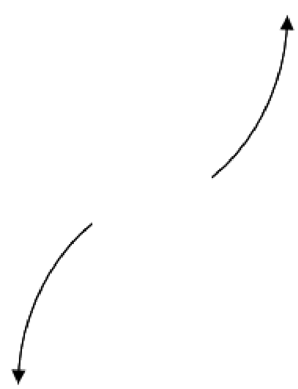
A.



C.



B.



D.

E. None of the above.

**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

20. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-1}{3}, 1, \text{ and } \frac{-2}{5}$$

The solution is $15x^3 - 4x^2 - 9x - 2$, which is option C.

A. $a \in [10, 17], b \in [3, 11], c \in [-9.39, -8.23],$ and $d \in [-0.3, 4.6]$

$15x^3 + 4x^2 - 9x + 2$, which corresponds to multiplying out $(3x - 1)(x + 1)(5x - 2)$.

B. $a \in [10, 17], b \in [10, 23], c \in [-1.88, -0.96],$ and $d \in [-2.8, -0.2]$

$15x^3 + 16x^2 - x - 2$, which corresponds to multiplying out $(3x - 1)(x + 1)(5x + 2)$.

C. $a \in [10, 17], b \in [-7, -3], c \in [-9.39, -8.23],$ and $d \in [-2.8, -0.2]$

* $15x^3 - 4x^2 - 9x - 2$, which is the correct option.

D. $a \in [10, 17], b \in [-7, -3], c \in [-9.39, -8.23],$ and $d \in [-0.3, 4.6]$

$15x^3 - 4x^2 - 9x + 2$, which corresponds to multiplying everything correctly except the constant term.

E. $a \in [10, 17], b \in [-18, -11], c \in [-4.09, -2.6],$ and $d \in [-0.3, 4.6]$

$15x^3 - 14x^2 - 3x + 2$, which corresponds to multiplying out $(3x - 1)(x - 1)(5x + 2)$.

**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(3x + 1)(x - 1)(5x + 2)$

---

21. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{7}{3}, 1, \text{ and } \frac{-7}{2}$$

The solution is $6x^3 + x^2 - 56x + 49$, which is option C.

A. $a \in [0, 14], b \in [28, 31.1], c \in [12, 15],$ and $d \in [-57, -44]$

$6x^3 + 29x^2 + 14x - 49$, which corresponds to multiplying out $(3x + 7)(x - 1)(2x + 7)$.

B. $a \in [0, 14], b \in [0.9, 2], c \in [-60, -55],$ and $d \in [-57, -44]$

$6x^3 + x^2 - 56x - 49$, which corresponds to multiplying everything correctly except the constant term.

C. $a \in [0, 14], b \in [0.9, 2], c \in [-60, -55],$ and $d \in [48, 54]$

* $6x^3 + x^2 - 56x + 49$, which is the correct option.

D. $a \in [0, 14], b \in [40.6, 41.8], c \in [82, 89],$ and $d \in [48, 54]$

$6x^3 + 41x^2 + 84x + 49$, which corresponds to multiplying out $(3x + 7)(x + 1)(2x + 7)$.

E. $a \in [0, 14], b \in [-4.2, 0.2], c \in [-60, -55],$ and $d \in [-57, -44]$

$6x^3 - 1x^2 - 56x - 49$, which corresponds to multiplying out $(3x + 7)(x + 1)(2x - 7)$.

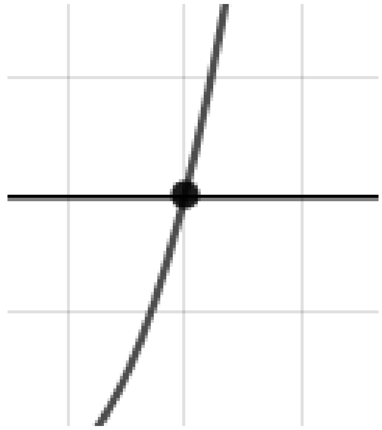
**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(3x - 7)(x - 1)(2x + 7)$

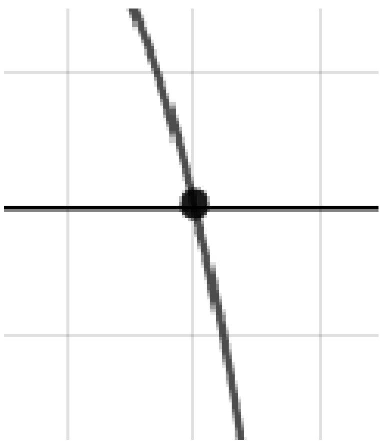
---

22. Describe the zero behavior of the zero $x = -4$ of the polynomial below.

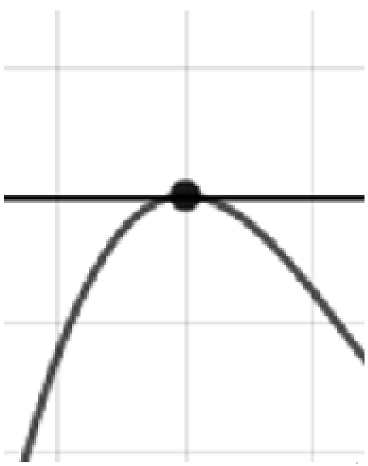
$$f(x) = -4(x + 4)^5(x - 4)^8(x - 9)^3(x + 9)^4$$

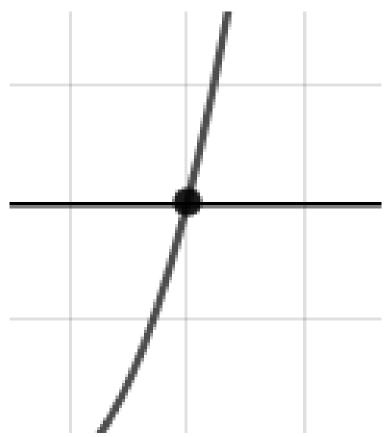
The solution is the graph below, which is option D.



A. 

C. 

B. 

D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

23. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$5 - 2i \text{ and } 1$$

The solution is $x^3 - 11x^2 + 39x - 29$, which is option A.

A. $b \in [-14, -9], c \in [37, 44]$, and $d \in [-34, -23]$

   * $x^3 - 11x^2 + 39x - 29$, which is the correct option.

B. $b \in [2, 13], c \in [37, 44]$, and $d \in [27, 33]$

   $x^3 + 11x^2 + 39x + 29$, which corresponds to multiplying out $(x - (5 - 2i))(x - (5 + 2i))(x + 1)$.

C. $b \in [-2, 6], c \in [-2, 5]$, and $d \in [-6, 1]$

   $x^3 + x^2 + x - 2$, which corresponds to multiplying out $(x + 2)(x - 1)$.

D. $b \in [-2, 6], c \in [-6, -5]$, and $d \in [0, 8]$

   $x^3 + x^2 - 6x + 5$, which corresponds to multiplying out $(x - 5)(x - 1)$.

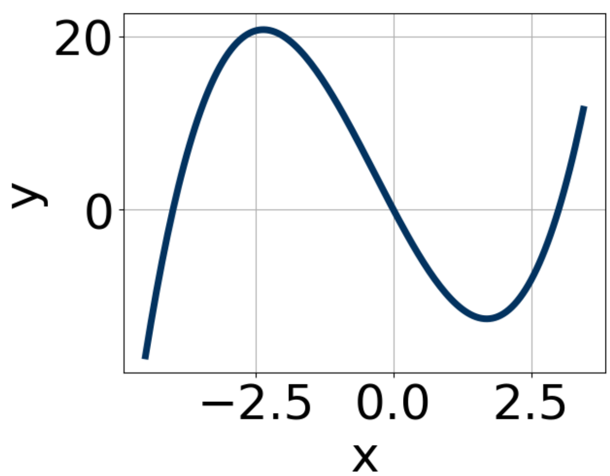
E. None of the above.

   This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

**General Comment:** Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (5 - 2i))(x - (5 + 2i))(x - (1))$.

---

24. Which of the following equations *could* be of the graph presented below?




The solution is $7x^9(x + 4)^{11}(x - 3)^9$, which is option B.

A. $-11x^6(x + 4)^{11}(x - 3)^5$

   The factor $x$ should have an odd power and the leading coefficient should be the opposite sign.

B. $7x^9(x + 4)^{11}(x - 3)^9$

   * This is the correct option.

C. $-6x^7(x + 4)^5(x - 3)^5$

   This corresponds to the leading coefficient being the opposite value than it should be.

D. $6x^8(x + 4)^4(x - 3)^{11}$

   The factors 0 and $-4$ have have been odd power.

E. $8x^8(x+4)^5(x-3)^7$

The factor 0 should have been an odd power.

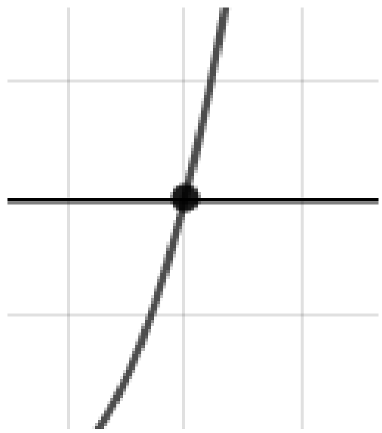
**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

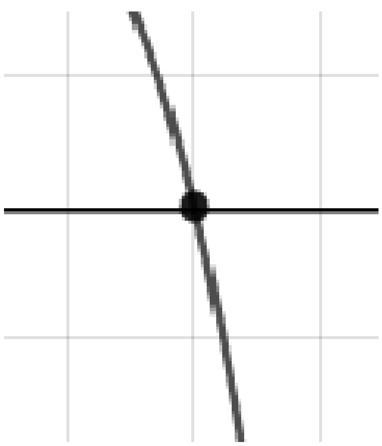
---

25. Describe the zero behavior of the zero $x = -8$ of the polynomial below.

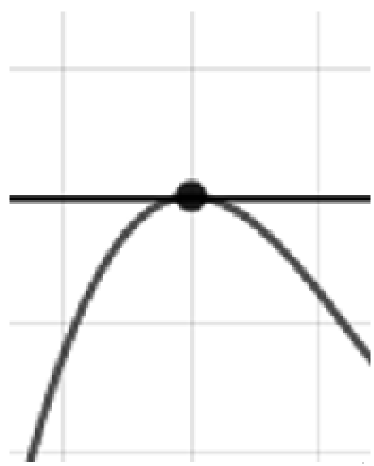
$$f(x) = 4(x-7)^5(x+7)^3(x+8)^9(x-8)^8$$

The solution is the graph below, which is option D.



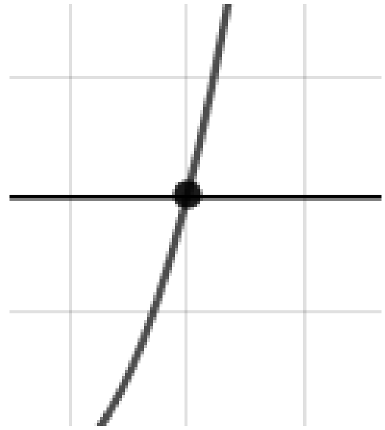


A.



B.

C. 

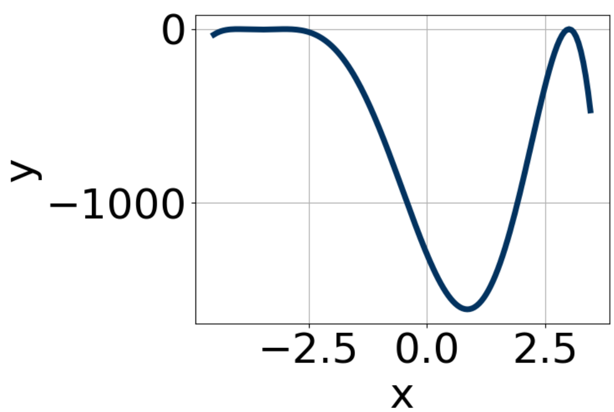
D. 

E. None of the above.

**General Comment:** You will need to sketch the entire graph, then zoom in on the zero the question asks about.

---

26. Which of the following equations *could* be of the graph presented below?




The solution is $-4(x+4)^4(x-3)^{10}(x+3)^4$, which is option B.

A. $16(x+4)^{10}(x-3)^{10}(x+3)^6$

This corresponds to the leading coefficient being the opposite value than it should be.

B. $-4(x+4)^4(x-3)^{10}(x+3)^4$

* This is the correct option.

C. $14(x+4)^{10}(x-3)^4(x+3)^{11}$

The factor $(x+3)$ should have an even power and the leading coefficient should be the opposite sign.

D. $-7(x+4)^4(x-3)^{11}(x+3)^7$

The factors $(x-3)$ and $(x+3)$ should both have even powers.

E. $-10(x+4)^{10}(x-3)^6(x+3)^{11}$

The factor $(x+3)$ should have an even power.

**General Comment:** General Comments: Draw the x-axis to determine which zeros are touching (and so have even multiplicity) or cross (and have odd multiplicity).

---

27. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $x^3 + bx^2 + cx + d$.

$$5 - 2i \text{ and } 4$$

The solution is $x^3 - 14x^2 + 69x - 116$, which is option A.

A. $b \in [-17, -13], c \in [69, 79]$, and $d \in [-116, -115]$

   * $x^3 - 14x^2 + 69x - 116$, which is the correct option.

B. $b \in [-7, 5], c \in [-5, 6]$, and $d \in [-9, -2]$

   $x^3 + x^2 - 2x - 8$, which corresponds to multiplying out $(x + 2)(x - 4)$.

C. $b \in [-7, 5], c \in [-13, -6]$, and $d \in [10, 27]$

   $x^3 + x^2 - 9x + 20$, which corresponds to multiplying out $(x - 5)(x - 4)$.

D. $b \in [14, 16], c \in [69, 79]$, and $d \in [114, 119]$

   $x^3 + 14x^2 + 69x + 116$, which corresponds to multiplying out $(x - (5 - 2i))(x - (5 + 2i))(x + 4)$.

E. None of the above.

   This corresponds to making an unanticipated error or not understanding how to use nonreal complex numbers to create the lowest-degree polynomial. If you chose this and are not sure what you did wrong, please contact the coordinator for help.

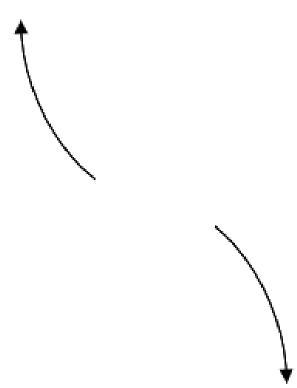
**General Comment:** Remember that the conjugate of $a + bi$ is $a - bi$. Since these zeros always come in pairs, we need to multiply out $(x - (5 - 2i))(x - (5 + 2i))(x - (4))$.

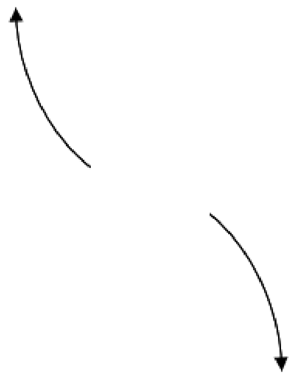
---

28. Describe the end behavior of the polynomial below.

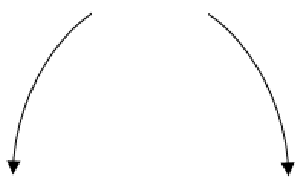
$$f(x) = -9(x + 2)^4(x - 2)^5(x - 6)^5(x + 6)^7$$

The solution is the graph below, which is option A.

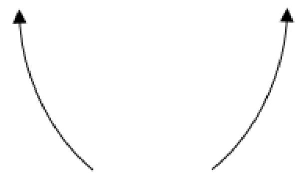




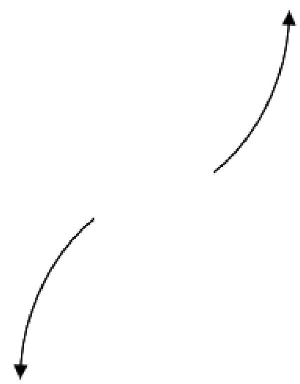
A.



B.



C.



D.

E. None of the above.

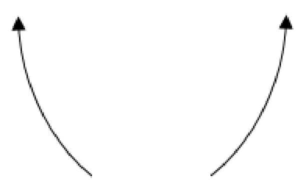
**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

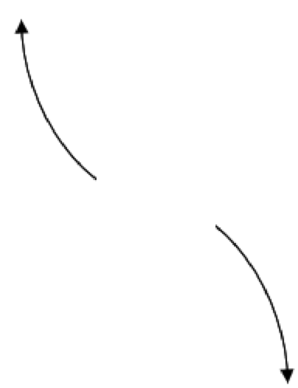
---

29. Describe the end behavior of the polynomial below.

$$f(x) = 9(x+3)^2(x-3)^3(x-4)^4(x+4)^5$$

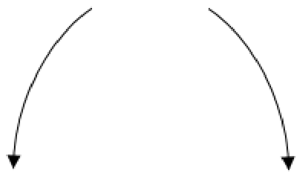
The solution is the graph below, which is option C.



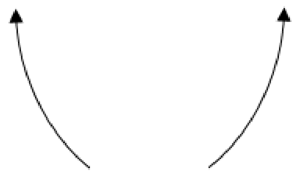




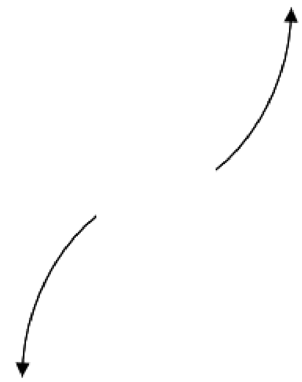
A.



B.



C.



D.

E. None of the above.

**General Comment:** Remember that end behavior is determined by the leading coefficient AND whether the **sum** of the multiplicities is positive or negative.

---

30. Construct the lowest-degree polynomial given the zeros below. Then, choose the intervals that contain the coefficients of the polynomial in the form $ax^3 + bx^2 + cx + d$.

$$\frac{-7}{4}, \frac{-7}{5}, \text{ and } 4$$

The solution is $20x^3 - 17x^2 - 203x - 196$, which is option C.

A. $a \in [20, 23], b \in [-144, -139], c \in [301, 307], \text{ and } d \in [-196, -195]$

$20x^3 - 143x^2 + 301x - 196$, which corresponds to multiplying out $(4x - 7)(5x - 7)(x - 4)$.

B. $a \in [20, 23], b \in [9, 18], c \in [-207, -199], \text{ and } d \in [189, 200]$

$20x^3 + 17x^2 - 203x + 196$, which corresponds to multiplying out $(4x - 7)(5x - 7)(x + 4)$.

C. $a \in [20, 23], b \in [-19, -15], c \in [-207, -199], \text{ and } d \in [-196, -195]$

* $20x^3 - 17x^2 - 203x - 196$, which is the correct option.

D. $a \in [20, 23], b \in [-92, -78], c \in [-26, -20], \text{ and } d \in [189, 200]$

$20x^3 - 87x^2 - 21x + 196$, which corresponds to multiplying out $(4x - 7)(5x + 7)(x - 4)$.

E. $a \in [20, 23], b \in [-19, -15], c \in [-207, -199], \text{ and } d \in [189, 200]$

$20x^3 - 17x^2 - 203x + 196$, which corresponds to multiplying everything correctly except the constant term.

**General Comment:** To construct the lowest-degree polynomial, you want to multiply out $(4x + 7)(5x + 7)(x - 4)$

---